A Risk Factor Profile for Pre-diabetes: Biochemical, Behavioural, Psychosocial and Cultural Factors.

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Abstract

In this study a profile is presented of a group of people diagnosed with pre-diabetes and who volunteered to be part of a lifestyle intervention to improve their health. Baseline (pre-intervention) data on biochemical, anthropometric, psychosocial, cultural and lifestyle factors were collected, providing a picture of the extent to which the behaviours of the participants were suboptimal for health. The sample enabled comparison of a Chinese-Australian group with an Anglo-Australian group, as well as male-female comparisons. Participants reported several barriers to healthy eating and exercise, with negative mood, particularly depression, significantly associated with more perceived barriers and weaker motivation to change. Men were less healthy eaters than women. The Anglo-Australian pre-diabetics were characterised by biochemical and anthropomorphic features reflecting the metabolic syndrome, showing risk factors not only for diabetes but also for cardio-vascular disease. The Chinese sample did not reflect metabolic syndrome risk factors to the same extent and, possibly as a consequence, were less motivated to change their behaviour in response to their diagnosis of pre-diabetes. The implications for lifestyle interventions were discussed.

Keywords: pre-diabetes, lifestyle, intervention

Introduction

Type 2 Diabetes Mellitus is a chronic metabolic disorder where blood glucose levels become elevated due to the body producing little or no insulin or not being able to access or use the insulin properly (NHMRC, 2001; WHO, 2003). Prior to the development of diabetes, there is a period in which the person suffers from impaired glucose metabolism, with blood sugars that are elevated but not yet high enough to be diagnosed with diabetes, a condition known as pre-diabetes. Pre-diabetes may manifest itself as either elevated fasting blood sugars (impaired fasting glucose, IFG) or elevated post glucose load blood sugars (impaired glucose tolerance, IGT), and is widely recognised to be an intermediary stage in the development of Type 2 diabetes (The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, ECDCD, 2003).

A clear link has been established between Type 2 diabetes and the development of a number of long term health complications including coronary heart disease, stroke, kidney disease, neuropathy, and blindness (NHMRC, 2001; WHO, 2003). Because the pre-diabetic state is often asymptomatic, people can go for many years without detection of their condition (Leiter et al., 2001). In fact a number of large scale population screening studies have indicated a ‘tip of the iceberg’ phenomenon, in that those people with diagnosed pre-diabetes or diabetes represent only a portion of the true prevalence of the conditions (e.g., Gu et al., 2003; King & Rewers, 1993; Leiter et al., 2001; Welborn, Reid & Marriott, 1997). Furthermore, by the time they are diagnosed with Type 2 diabetes, many individuals are already experiencing complications such as retinopathy or cardio-vascular disease (Barr et al., 2005; Tapp et al., 2000). There is therefore a growing recognition that Type 2 diabetes and its precursors are responsible for a considerable proportion of the disease burden both globally and locally in Australia, and that early intervention is an important part of reducing this burden.

Prevalence of Type 2 diabetes worldwide is difficult to establish but has been estimated by different studies as ranging from 2.8 to 4%, and is projected to increase to up to approximately 5% by 2030 (Gu et al., 2003; King, Aubert & Hermen, 1998; Wild, Roglie, Sieree, & King, 2004). However, the prevalence and incidence of Type 2 diabetes and pre-diabetes have been found to vary markedly across cultures. Currently approximately 7.4% of Australians have Type 2 diabetes and a further 16.8% have pre-diabetes (Barr et al., 2005). As has been the case across the globe, the incidence of these diseases in Australia has been consistently increasing with approximately 280 new
diagnoses of Type 2 diabetes per day in Australia (Barr et al., 2005).

Traditional communities within undeveloped countries (e.g., Africa, South America) have typically been found to have a low prevalence of both Type 2 diabetes and pre-diabetes, whilst other rapidly developing Asian countries show a much higher prevalence of these conditions (King & Rewers, 1993). Of particular concern has been the increase in prevalence of diabetes in China, which is now recognised as having one of the largest growing populations of people with this disease (Gu et al., 2003; King & Rewers, 1993). A recent large scale population based study in China reported that 5.5% of the Chinese population had diabetes and a further 7.3% had IGT (Gu et al., 2003). Furthermore, Gu and colleagues found that three out of four participants with Type 2 diabetes or pre-diabetes in their large population based sample were previously undiagnosed (Gu et al., 2003).

There is evidence to suggest that when Chinese people move away from their indigenous communities, their risk of developing pre-diabetes and Type 2 diabetes increases. For example, one study in the United States found that Chinese migrant populations were at increased risk of developing both pre-diabetes and Type 2 diabetes relative to their non-migrant counterparts and the US white population (King & Rewers, 1993). It has been argued that this observation might at least in part, be due to the fact that when Chinese people migrate to westernised countries or move to more industrialised environments, they usually undergo major changes to their diet, occupation and activity levels (Jayne & Rankin, 2001). Taken together these findings indicate that people of Chinese ethnic background may have a particular vulnerability to the development of diabetes and therefore the associated complications.

There are some indications that there may also be gender differences in the manifestations of pre-diabetes. Population studies in China, Australia and Mauritius have found that impaired fasting glucose tends to be more prevalent in males than females, while impaired glucose tolerance tends to be more prevalent in females than males (Dacoda Study Group, 2003; Dunstan et al., 2002; Williams et al., 2003).

Whilst there is a large body of epidemiological research that has explored the prevalence of pre-diabetes and Type 2 diabetes around the globe, there have been fewer studies that have explored cultural or gender differences in the manifestations of diabetes. A number of risk factors have been linked to the development of Type 2 diabetes, including genetic predisposition, metabolic and psychosocial factors (Barr et al., 2005; Fletcher, Gulanick & Lamendola, 2002). In Western/European cultures the development of pre-diabetes has been closely linked to the presence of Metabolic Syndrome, a cluster of metabolic abnormalities that are believed to have a common

physical exercise and dietary modification, the progression to Type 2 diabetes was reduced by up to 58% (Ekirsson et al., 1999; Tuomilehto, et al., 2001; Pan et al., 1997). It therefore seems evident that early intervention relating to modifiable risk factors such as diet and exercise is the key to stemming the flow of the so-called ‘diabetes epidemic’.

While it is widely agreed that lifestyle intervention is a major key to diabetes prevention, readiness to undergo such modifications and self-confidence in one’s ability to change (i.e., self efficacy) are also important predictors of behaviour change (Bandura & Adams, 1977; Prochaska, DiClemente & Norcross, 1992). Self-efficacy has been consistently associated with diabetes related self-care in terms of diet, exercise and blood glucose testing across a range of samples (Sarkar, Fisher & Schillinger, 2006; Williams & Bond, 2002). Furthermore empowerment in the form of education about daily self-care requirements, problem solving and the provision of instrumental support has been associated with both improved diabetes-relevant self-efficacy and glycemic control (DeCoster & George, 2005).

Given the emerging evidence that a large proportion of diabetes world wide goes undiagnosed until the onset of complications (Leiter et al., 2001), coupled with the knowledge that effective intervention programs can significantly improve diabetes and pre-diabetes related self-care and reduce the progression to diabetes, it is important to understand the physical, biochemical and psychosocial manifestations of the early signs of diabetes, so that ‘at risk’ individuals can be detected early and targeted for prevention programs.

The aim of our current study was therefore to explore these risk factors by profiling a large sample of Victorians with pre-diabetes who were also prepared to participate in a lifestyle intervention to improve their health (the Healthy Living Course: HLC). The study was part of a larger Department of Human Services (Victoria) funded RCT (still in progress), in which the effectiveness of a group diabetes prevention program is being evaluated. Ultimately, the data being collected in this study will give information on the outcomes of a lifestyle program in relation to pre-diabetes and its risk factors.

Specifically we sought to examine the anthropometric, biochemical, psychosocial and behavioural profiles of people with pre-diabetes, and assess gender and cultural differences within this sample. The cultural differences examined related to opportunistic features of the sample population and involved a comparison between ethnic Chinese and Anglo-Australian groups. The purpose was not to conduct a study from which generalisation to the Chinese population at large could be made, but to compare subgroups of pre-diabetics within our sample in order to examine the possibility that different groups could have different pre-diabetes risk profiles.

Anthropometric and biochemical indicators were chosen from well established risk factors for pre-diabetes and included age, waist circumference, body mass index, low density lipid (LDL) cholesterol, high density lipid (HDL) cholesterol, triglycerides, systolic and diastolic blood pressure, fasting and 2 hour post glucose load blood glucose levels. Psychosocial factors examined were derived from the literature suggesting the importance of motivation to change, perceived barriers to change (self-efficacy with respect to exercise and diet), mood and knowledge of risks and how to reduce them in facilitating outcomes (Bandura & Adams, 1977; DeCoster & George, 2005; Prochaska et al., 1992; Sarkar et al., 2006; Williams & Bond, 2002). Finally, behavioural variables studied included exercise and eating patterns, linked in previous literature to healthier outcomes (Ekirsson et al., 1999; Tuomilehto, et al., 2001; Pan et al., 1997).

Method

Participants

Recruitment of people considered at-risk of diabetes occurred across three regions of Victoria, Australia – two metropolitan regions and a northern Victorian rural population. One of the metropolitan areas was particularly targeted because of their large population of people of ethnic Chinese origin.

Participants were referred to the study by general medical practitioners within the catchment areas, through opportunistic community screening for diabetes risk factors, or through self-reported risk factor assessments based on community mail outs/publicity. While recruitment strategies were varied, there were no systematic differences between strategies used to recruit Chinese and Anglo-Australians –the two samples were predominantly recruited through referrals from their general practitioner. Participants were deemed at risk of diabetes if they had one or more of the following risk factors: (i) over 55 years; (ii) over 45 years and also were overweight, had high blood pressure, or were physically inactive; (iii) over 34 years and from cultural backgrounds known to be at risk of Type 2 diabetes; (iv) had a history of cardiovascular disease, or previously recorded elevated blood glucose (but not diabetic); (v) women who had experienced gestational diabetes or polycystic ovarian syndrome.

Having established risk factors for diabetes, participants were considered for inclusion in the study if they also satisfied the clinical diagnostic criteria for pre-diabetes and had agreed to participate in the Go for your Life Diabetes Prevention program (The Healthy Living Course). Diagnosis of pre-diabetes was via an Oral Glucose Tolerance Test (OGTT) applying the World Health Organisation (1985) diagnostic criteria for pre-diabetes. Within this criteria the participant was diagnosed as having pre-diabetes if they demonstrated Impaired Fasting Glucose (IFG), as indicated by a
fasting plasma glucose (FPG) between 6.1 and 7.0 mmol/l with a non-diabetic (<11.1mmol/l) 2 hour post glucose load plasma glucose (2hPG); Impaired Glucose Tolerance (IGT), as indicated by a 2hPG between 7.8 and 11.0mmol/l, with a non-diabetic FPG (<6.1mmol/l); or both IFG and IGT.

This study reports data from 261 participants, 104 males and 157 females. Forty of the participants self-identified as coming from a Chinese cultural background (17 males & 23 females), and are referred to in this paper as the Chinese sample. Thirty-eight participated in Cantonese or Mandarin speaking HLC programs, and two were integrated into the English speaking courses. Two hundred and twenty-one participants were from an Anglo-Australian background, classified as such if they were born in Australia or an English-speaking country (e.g., United Kingdom, New Zealand) and self reported an “Anglo” background. Self report was used as the criterion for cultural background as self identification is considered the most basic element of cultural identity (Ashmore, Deaux & McLaughlin-Volpe, 2004; Phinney & Ong, 2007). For the total sample, ages ranged from 26 to 86 years (M=62.77 years, SD=10.63 years).

The Chinese and Anglo-Australian groups did not differ on age, F(1, 259) =0.1, ns; proportion of males and females, χ²(1)=.14, ns; or employment, χ²(3) =1.69, ns. Approximately 55% of participants were retired, 20% were in full time work, 19% were in part time work and 6% were unemployed. The two groups did however differ in educational background with a higher proportion of Chinese participants having engaged in post-secondary education than Anglo-Australians χ²(6) =21.04, p<.005. For this reason, education was used as a covariate for cultural group comparisons of self-report data.

**Measures**

Measures included the anthropometry assessment (completed by the general practitioner) and a self report questionnaire (completed by the participant) which assessed demographic and health information, diabetes knowledge, eating and physical activity patterns and a range of psychosocial factors including motivation to engage in lifestyle change, self efficacy with respect to diet and exercise, and mood. The questionnaire was translated into Chinese to cater for groups run within Chinese communities. Translated questionnaires were independently back translated and checked for accuracy of translation.

**Anthropometry/Biochemistry**

The Anthropometry and Biochemistry Form was a general practitioner (GP) report of diabetes-relevant medical factors including height and weight (for BMI calculation), waist circumference, blood pressure and biochemical indicators including triglycerides, High Density Lipid (HDL) cholesterol, Low Density Lipid (LDL) cholesterol and OGTT (FPG & 2hPG).

**Motivation to Change**

The motivation to change measure was based on the Prochaska, DiClemente and Norcross (1992) trans-theoretical model of behaviour. A five response option, forced-choice categorical scale was designed to assess whether participants were at the pre-contemplation (scored 1), contemplation (2), preparation (3), action (4) or maintenance (5) stage with respect to lifestyle change in relation to maintaining appropriate weight, eating healthy food and engaging in physical exercise. Higher rating represented a stronger motivation to change.

**Diabetes Related Self-efficacy**

This was assessed via two scales, one measuring exercise self efficacy and the other, dietary self efficacy. The scales were based on the concept of self-efficacy as described by Bandura and Adams (1977), who argued that measures of self efficacy need to be specific (rather than general) and closely match the behaviour that is being targeted for change. Items were derived from the Stanford University Patient Education Research Centre (SUPERC) Self efficacy for Diabetes Scale (http://patienteducation.stanford.edu/research/sedibetes.pdf) and the Diabetes Empowerment Scale (Anderson, Funnell, Fitzgerald & Marbero, 2000), and adapted for use with a pre-diabetic population, and to reflect the specific behaviour changes targeted by the HLC (diet and exercise). Participants were asked to rate how confident they felt about engaging in exercise under seven ‘barrier’ conditions (e.g., ‘when I am feeling a bit tired’) and how they felt about maintaining a healthy diet under eleven conditions (e.g. ‘when I am upset’). Responses were rated on 5-point Likert scales ranging from “not at all confident” (1) to “very confident” (5). Ratings could be averaged to give a mean exercise or dietary self-efficacy score, or treated independently to assess profiles of barriers to change. The Cronbach α reliabilities of the exercise self-efficacy and the diet self-efficacy scales were 0.87 and 0.91 respectively for the Anglo-Australian sample and both alphas were 0.87 for the Chinese sample.

**Diabetes Knowledge**

Diabetes knowledge was assessed using a 13-item true/false Diabetes Knowledge Scale developed for the current study to assess understanding of risk factors, lifestyle factors and potential consequences of Type 2 diabetes (e.g., “Diabetes is a condition where there is too much glucose found in the blood”). Items were adapted from existing scales (e.g., http://www.endocrinologist.com/diabtest.htm), and devised on the basis of diabetes related information provided on relevant websites (Diabetes Australia, SUPERC), and from information provided in the HLC program manual. Correct answers were summed to yield a total diabetes knowledge score (α reliability = 0.76 for Anglo-Australian sample; 0.78 for Chinese sample).

**Mood**

Mood was assessed along two dimensions, positive mood state (positive affect) and negative mood...
state (depression, anxiety, stress). The Positive Affect (PA) sub-scale of the Positive Affect and Negative Affect Scale - PANAS (Watson, Clark & Tellegen, 1988) was used to assess the degree of positive feelings in individuals. The PA is a 10 item self-report scale that asks participants to rate the degree to which they have felt positive emotions (e.g., excited) over the past week. Items are scored on a 5 point Likert scale, ranging from 1 ‘very slightly or not at all’ to 5 ‘extremely’, with ratings from the 10 items averaged to yield an overall PA score. Validation studies indicate that the PA has acceptable internal consistency and validity when used with a range of populations (Crawford & Henry, 2004; Watson et al., 1988). The Cronbach alpha for the scale was 0.92 in this study for the Anglo-Australian group and 0.91 for the Chinese group.

The shortened version of the Depression, Anxiety and Stress Scale – DASS21 (Lovibond & Lovibond, 1995) was used to measure negative emotional states. The DASS21 contains three 7-item subscales measuring Depression, Anxiety and Stress with scores on each sub-scale averaged to yield an overall score on each dimension. Further, the DASS21 has been validated with Chinese samples (Taouk, Lovibond, & Laube, 2001), shown to have excellent internal consistency and validity when used with a range of populations (Crawford & Henry, 2004; Lovibond & Lovibond, 1995). The Cronbach alpha for the scale was 0.92 in this study for the Anglo-Australian group and 0.78 and 0.86 respectively for the Anglo-Australian sample and 0.73, 0.62 and 0.73 for the Chinese sample.

**Physical Exercise Patterns** An adapted version of the International Physical Activity Scale (Craig et al., 2003) was used to assess the frequency and duration of physical activity. Participants were asked how often and for how long they had engaged in five types of activity within the last week, including walking continuously, vigorous household chores, gardening, various sporting/exercise activities and moderate activities such as golf, gentle swimming and lawn bowls. To assess inactivity levels, participants were asked how many hours they had spent watching TV or videos, and using a computer outside of normal work activities. Activity and inactivity overall scores (in hours/week) were calculated by adding the times spent on active pursuits and the times spent on passive activities respectively.

**Eating Patterns** Eating patterns were assessed using the Food Choices Questionnaire (FCQ), a 16 item measure of eating patterns which aimed to tap the degree to which participants make healthy food choices. It was developed for this study based on the Dietary Guidelines for Australian Adults (NHMRC, 2003). Participants were asked to rate on a 4 point Likert scale ranging from 1 = "Almost never" to 4 = "Usually/most days", the frequency with which they made certain food choices (e.g., "How many days in an average week would you eat at least 1 cup of cereal flakes, 2 slices of bread or 1 cup of cooked rice or pasta?"). Ratings could be added to give an overall healthy eating score (a reliability = 0.67 for the Anglo-Australian sample; 0.61 for the Chinese sample).

**Procedure** Once participants were identified as being at risk of pre-diabetes they were referred for an OGTT to determine whether or not they had pre-diabetes. Those participants with pre-diabetes were offered participation in a lifestyle intervention for the prevention of diabetes. Those who agreed completed the questionnaire battery described above, prior to beginning the Healthy Living Course. The volunteer rate of those diagnosed was very high (93%).

**Analyses** Males and females, Chinese and Anglo-Australian groups were compared on the anthropometric/biochemical variables (waist circumference, BMI, systolic and diastolic blood pressure, triglycerides, HDL cholesterol, LDL cholesterol, FPG and 2hPG), cognitive variables (motivation to change, diet and exercise self-efficacy, knowledge), mood (depression, anxiety, stress, positive affect), activity/inactivity and eating behaviour variables using a series of 2 X 2 MANOVAS or MANCOVAS (and a 2 X 2 ANCOVA in the case of eating behaviour). As mentioned previously, education was used as a covariate in analyses of self-report data. Dependent variables were grouped in sets for MANOVA/MANCOVA (rather than analysed using a large number of ANOVAS/ANCOVAs) to reduce the likelihood of Type I errors. Although the sample size was relatively small for the Chinese group, cell sizes for the MANOVAS/MANCOVAS fell well within the criterion of being larger than the number of dependent variables in any set. Additionally, partial eta-squared was used as a measure of effect size for significant differences found.

**Results**

**Anthropometric and Biochemical Profile** Mean scores for all anthropometric and biochemical indicators are displayed in Table 1 alongside culture and gender specific IDF (2006) diagnostic criteria for metabolic syndrome. In addition to the IDF criteria, appropriate cultural standards were used to assess waist and BMI in the Chinese group (Ko et al., 2001)

As can be seen from Table 1, on average the pre-diabetic participants from an Anglo-Australian background displayed body mass indices (BMI) in the ‘obese’ range (BMI>30) and showed a clustering of metabolic abnormalities consistent with the diagnostic criteria for Metabolic Syndrome (IDF, 2006). Both males and females of Anglo-Australian background on
average displayed waist circumferences, triglyceride levels, systolic blood pressure measurements and fasting plasma glucose levels above those specified in the IDF definition of Metabolic Syndrome. In contrast, participants from a Chinese background displayed BMIs in the overweight range (BMI 23 - 26kg/m²) and did not on average, meet the diagnostic criteria for metabolic syndrome.

Whilst the female participants from a Chinese background had waist measurements somewhat in excess of those required for metabolic syndrome, males did not. However, the larger waist measurements of the Chinese females (in comparison with IDF specifications) were not associated with the cluster of other abnormalities indicative of Metabolic Syndrome. Indeed, both male and female Chinese participants on average displayed triglyceride levels, HDL cholesterol levels, systolic and diastolic blood pressure that fell outside the diagnostic criteria for Metabolic Syndrome.

All participants exhibited impaired glucose tolerance or impaired fasting glucose or both (as required for diagnosis of pre-diabetes). However, on average, both the Anglo and Chinese males and females displayed mean fasting plasma glucose levels below the pre-diabetic range, and impaired glucose tolerance as indicated by elevated two-hour post load plasma glucose levels.

A 2 x 2 MANOVA with culture (Chinese/Anglo-Australian) and gender as the independent variables and waist circumference, BMI, triglyceride levels, HDL and LDL-cholesterol levels, systolic and diastolic blood pressure, fasting and 2 hour plasma glucose as the dependent variables, revealed that the combined biochemical and anthropometric measures were significantly associated with both culture (Wilks’ λ = .79, F(9,160)= 4.83, p<.001, η²=.21) and gender (Wilks’ λ = .15, F(9,160)= 3.11, p<.01, η²=.15) with no significant interaction between culture and gender.

Examination of the univariate effects revealed that Chinese participants displayed significantly smaller waist circumferences F(1, 168)=29.54, p<.001, η²=.15; lower BMI, F(1, 168)=30.59, p<.001; η²=.15, lower fasting blood glucose, F(1, 168)= 4.11, p<.05; η²=.024 and lower systolic blood pressure, F(1, 168)= 12.14, p<.005, η²=.067, than did the Anglo-Australian participants. The female participants displayed significantly higher HDL-cholesterol levels than males, F(1, 168)=10.41, p<.005. η²=.058.

Psychosocial Profile

Cognitive Variables A 2(culture) x 2(gender) MANCOVA with education level as a covariate and motivation to change, exercise self-efficacy, diet self-efficacy and diabetes related knowledge as the dependent variables, revealed that the combined cognitive measures were significantly associated with culture (Wilks’ λ = .915, F(4, 202)= 4.68, p<.005, η²=.085) but not gender (Wilks’ λ = .95, F(4, 202)= 2.42, ns), with no significant interaction and no significant covariate effect of education. Chinese participants, M=3.42, SD= 1.25, reported significantly less motivation to change than did Anglo-Australians, M=4.09, SD=.87, F(1, 205) = 13.65, p<.001, η²=.062. Over half the Chinese participants (59%) were still in pre-contemplation, contemplation and preparation stages of motivation to change, in comparison with only 23% of Anglo-Australians at these pre-action stages.

Chinese participants displayed significantly lower levels of self efficacy in relation to maintaining a healthy exercise regime, M= 3.27, SD=.79, than did Anglo-Australians, M=3.58, SD=.81, F(1, 205) =6.09, p<.05, η²=.029, but the groups did not differ with respect to diet self-efficacy. Barriers to maintaining an exercise regime were similar for both groups, with small differences in degree only. Major barriers included “Not feeling up to exercise” for which 67% of all participants reporting that they were either ambivalent or not confident as to whether they would exercise in this situation. Busyness (56%) and tiredness (52%) were the next most frequently cited barriers to exercise. In general, participants seemed less concerned about barriers to healthy eating than they were about barriers to exercise. The most often reported barrier to healthy eating related to eating in groups. For example when celebrating (55%), when eating at a restaurant (48%), or when at a party (55%) participants were more ambivalent and less confident as to whether they could maintain a healthy diet. Participants were less concerned about mood factors as a barrier to healthy eating (e.g., Feeling upset, tense, bored or sad).

Knowledge scores indicated that Chinese participants displayed significantly lower levels of diabetes related knowledge, M= 8.03, SD= 3.05, than Anglo-Australians, M=8.68, SD=2.73, F(1, 205) =5.50, p<.05, η²=.026, although the difference was very small in terms of number of items correct. Whilst participants overall displayed a moderate level of knowledge about the nature, occurrence and prevention of diabetes, with a mean score of 8.40 (SD= 2.80) out of a possible score of 13, examination of item responses indicates that participants lacked knowledge in some areas that are important to the management and prevention of diabetes. The majority of participants (76%) knew that diabetes is a condition that involves elevated blood glucose levels, however they were less certain about the specifics of its occurrence. For example, the majority (53%) incorrectly though the onset was rapid rather than slow. Most were aware of the health risks associated with diabetes (e.g., risk of heart disease was understood by 88% and the risk of blindness by 93%), however they were not as certain about which conditions were not associated with the complications of diabetes (e.g., 73% incorrectly believed that lung disease was associated with Type 2 diabetes).
Table 1. Mean descriptive statistics for pre-diabetic males and females (Chinese and Anglo-Australian background) compared with International Diabetes Foundation Criteria for Metabolic Syndrome

<table>
<thead>
<tr>
<th>Measure</th>
<th>Anglo-Australian males</th>
<th>Anglo-Australian females</th>
<th>Chinese males</th>
<th>Chinese females</th>
<th>IDF Criteria Metabolic Syndrome (M=male; F=female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>64.01</td>
<td>9.73</td>
<td>61.92</td>
<td>10.82</td>
<td>62.88</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>91.29</td>
<td>16.48</td>
<td>83.98</td>
<td>18.16</td>
<td>64.57</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>30.19</td>
<td>5.44</td>
<td>32.15</td>
<td>7.24</td>
<td>24.12</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>104.42</td>
<td>13.97</td>
<td>97.71</td>
<td>15.90</td>
<td>86.12</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>1.84</td>
<td>1.13</td>
<td>1.64</td>
<td>0.69</td>
<td>1.37</td>
</tr>
<tr>
<td>HDL-C (mmol/l)</td>
<td>1.24</td>
<td>0.24</td>
<td>1.44</td>
<td>0.39</td>
<td>1.32</td>
</tr>
<tr>
<td>LDL-C (mmol/l)</td>
<td>2.93</td>
<td>0.94</td>
<td>3.07</td>
<td>0.78</td>
<td>3.05</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>130.944</td>
<td>14.85</td>
<td>132.66</td>
<td>13.51</td>
<td>121.77</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>74.95</td>
<td>9.80</td>
<td>77.83</td>
<td>9.66</td>
<td>75.46</td>
</tr>
<tr>
<td>FPG (mmol/l)</td>
<td>5.97</td>
<td>0.48</td>
<td>5.78</td>
<td>0.64</td>
<td>5.77</td>
</tr>
<tr>
<td>2hr PG (mmol/l)</td>
<td>8.31</td>
<td>1.71</td>
<td>8.27</td>
<td>1.57</td>
<td>8.32</td>
</tr>
</tbody>
</table>
Participants were generally less certain about the risk factors for development of diabetes (e.g., only 61% knew that Type 2 diabetes was more common in people over 30, and only 49% were aware that some ethnic groups are particularly vulnerable), however the vast majority (97%) was aware that the onset of diabetes could be delayed through lifestyle changes. The sample generally had limited knowledge about the dietary recommendations for people with diabetes, and the carbohydrate content of various foods.

**Mood** Positive affect, depression anxiety and stress scores for males and females of Chinese and Anglo-Australian cultural backgrounds are shown in Table 2. Overall the majority of participants were within the ‘normal’ range for depression (79.3%), anxiety (77.5%) and stress (83.5%). Only a small proportion of participants reported severe or extremely severe levels of depression (3.4%), anxiety (3.3%) or stress (3.0%) (Lovibond & Lovibond, 1995).

A 2(culture) x 2(gender) MANCOVA with education level as a covariate and times, stress and positive affect as the dependent variables, revealed that the combined mood measures were significantly associated with both culture (Wilks’ $\lambda = .922, F(4, 196) = 4.13, p<.01, \eta^2 = .078$) and gender (Wilks’ $\lambda = .93, F(4, 196) = 3.48, p<.01, \eta^2 = .066$). There was no significant covariate effect of education, however there was a significant interaction between culture and gender on the mood variables (Wilks’ $\lambda = .92, F(4, 196) = 4.45, p<.01, \eta^2 = .083$). Examination of the univariate effects revealed that Chinese participants reported significantly lower positive affect than Anglo-Australians, $F(1, 204) = 13.73, p<.001, \eta^2 = .065$. The Chinese also reported significantly higher levels of depression than the Anglo-Australians $F(1, 204) = 4.63, p<.05, \eta^2 = .023$ and females reported significantly higher levels of depression than males, $F(1, 204) = 10.37, p<.005, \eta^2 = .050$. The interaction between culture and gender was significant for depression, $F(1,204)=5.15, p<.05, \eta^2 = .025$, with Chinese females being more depressed than any other group.

**Behavioural Profile**

**Activity Levels** A 2(culture) x 2(gender) MANCOVA with education as a covariate and times spent on both physical activity and inactivity as the dependent variables, revealed that the combined measures were significantly associated with culture (Wilks’ $\lambda = .96, F(2, 188) = 3.27, p<.05, \eta^2 = .034$) but not gender (Wilks’ $\lambda = .002, F(2, 221) = .21, ns$). There was no significant covariate effect of education, however there was a significant interaction between culture and gender (Wilks’ $\lambda = .96, F(2, 188) = 3.77, p<.05, \eta^2 = .039$). Univariate analyses revealed that there were no significant main-effect cultural differences in physical activity levels, however Chinese participants spent significantly less time being inactive ($M= 13.1$ hrs, $SD= 10.8$ hrs) than did the Anglo-Australian participants ($M= 19.5$ hrs, $SD= 11.4$ hrs), $F(1, 189) = 6.23, p<.05, \eta^2 = .032$. There was also a significant interaction between culture and gender on level of activity $F(1, 189) = 7.56, p<.01, \eta^2 = .038$. The source of the interaction lay in the observation that Anglo-Australian males were more active than Anglo-Australian females, while Chinese females were more active than Chinese males.

**Eating Behaviours** A two way ANCOVA with education level as a covariate revealed that there were gender differences in overall eating patterns with males, $M= 3.02, SD=.35$, reporting less healthy eating habits on average than females, $M= 3.18, SD=.31, F(1,248) = 8.35, p < 0.005, \eta^2 = .033$. There was no significant culture difference, no significant interaction between culture and gender on eating patterns and no significant covariate effect of education.

**Relationship between Mood, Lifestyle and Cognitive Variables**

Pearson’s correlations between the mood, lifestyle and cognitive variables are displayed in Table 3. As can be seen from this table, depression, and to a lesser extent stress and anxiety were negatively correlated with all the cognitive variables (diet and exercise self efficacy, motivation to change and knowledge). However there was no evidence of negative correlations between depression, anxiety or stress and levels of physical activity or inactivity.

**Discussion**

The findings of the current study revealed that there were few differences between the biochemical profiles of males and females. Females displayed significantly higher HDL-cholesterol readings than did males, which is consistent with previous findings (Dobiasova, Urbanova, Rauchova, Samanek, & Fronlich, 1998). However, there were no sex differences in any of the other anthropometric or biochemical indicators. There were also few differences in the cognitive and behavioural profiles of males and females. They did not differ in overall activity or inactivity levels, however there were cultural group differences, with Anglo-Australian females reporting less activity, and Chinese females more activity, than males in their cultural group. Overall, females reported healthier overall dietary habits than males. This finding suggests that the focus of diabetes related interventions in relation to dietary changes may need to be somewhat different for males and females, although more research is needed.

Insert Table 3 about here
Table 2. Mean Depression, Anxiety and Stress (DASS-21) scores and positive affect scores (PANAS-PA) for Chinese and Anglo-Australian males and females with pre-diabetes.

<table>
<thead>
<tr>
<th></th>
<th>Anglo-Australian Male M (SD)</th>
<th>Female M (SD)</th>
<th>Male M (SD)</th>
<th>Female M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>4.17 (5.62)</td>
<td>5.31 (6.00)</td>
<td>4.27 (3.92)</td>
<td>10.71 (9.92)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>2.94 (3.68)</td>
<td>4.58 (5.89)</td>
<td>5.73 (4.40)</td>
<td>5.53 (4.98)</td>
</tr>
<tr>
<td>Stress</td>
<td>8.20 (6.81)</td>
<td>8.29 (7.50)</td>
<td>8.93 (6.66)</td>
<td>8.77 (7.32)</td>
</tr>
<tr>
<td>PANAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Affect</td>
<td>38.64 (6.51)</td>
<td>37.25 (6.99)</td>
<td>32.97 (4.87)</td>
<td>33.00 (6.05)</td>
</tr>
</tbody>
</table>

Table 3 The relationship between mood, lifestyle, and cognitive variables for people with pre-diabetes.

<table>
<thead>
<tr>
<th></th>
<th>Depression</th>
<th>Mood</th>
<th>Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Stress</td>
<td></td>
</tr>
<tr>
<td>Mean healthy eating score</td>
<td>- .20**</td>
<td>-.17**</td>
<td>-.13*</td>
</tr>
<tr>
<td>Mean exercise self-efficacy</td>
<td>-.33***</td>
<td>-.20**</td>
<td>-.21**</td>
</tr>
<tr>
<td>Mean diet self-efficacy</td>
<td>-.32***</td>
<td>-.26***</td>
<td>-.15*</td>
</tr>
<tr>
<td>Motivation to change</td>
<td>-.25***</td>
<td>-.08</td>
<td>-.17*</td>
</tr>
<tr>
<td>Mean diabetes related knowledge</td>
<td>-.12</td>
<td>-.11</td>
<td>-.14*</td>
</tr>
<tr>
<td>Mean activity</td>
<td>.00</td>
<td>.02</td>
<td>.03</td>
</tr>
<tr>
<td>Mean inactivity</td>
<td>.04</td>
<td>.06</td>
<td>.04</td>
</tr>
</tbody>
</table>

Note: ***= p<.001, **=p<.01, *=p<.05

into the pattern of eating differences characterising the sexes.

On average all participants reported barriers to ideal diabetes prevention practices in terms of both self-efficacy and diabetes related knowledge. Not feeling up to exercise, busyness and tiredness appeared to pose the greatest threat to regular exercise, while eating in groups when celebrating or at a party, posed the greatest challenge to maintaining a healthy diet. While overall participants had an awareness of some aspects of the occurrence of diabetes, they lacked knowledge in some areas that are important to the management and prevention of diabetes, such as the risk factors for the development of diabetes and the dietary recommendations for people with the condition.

Of particular interest were the different biological profiles of the Chinese and Anglo-Australian samples in this study. While not necessarily generalisable to these cultural groups overall, the profiles indicate that a ‘one-size fits all’ lifestyle intervention for people with pre-diabetes may need to be reconsidered. The Anglo-Australian group clearly fit the anthropometric and biochemical profile associated with Metabolic Syndrome, with large waist and elevated triglyceride, systolic blood pressure and fasting plasma glucose levels (IDF, 2006). This implies that they are not only at risk for the development of Type 2 diabetes, but they are also at increased risk of developing cardiovascular disease (Anderson et al., 2001; IDF, 2006). The Chinese participants on the other hand, while displaying blood glucose levels in the pre-diabetes range, did not display the biochemical and anthropometric indicators of Metabolic Syndrome to the same extent (even taking cultural standards into account), nor were they as inactive as the Anglo-Australians. This reduced level of overt symptomatology could possibly explain the observation that the Chinese also reported a lower motivation to change than did the Anglo-Australians, although this finding needs to be viewed in relation to possible limitations in the measures used in this study (see below). The lowered motivation to change of the Chinese group could also be associated with reduced exercise self-efficacy and lower diabetes knowledge than the Anglo-Australians, however it needs to be noted that these were small effects and should be viewed with caution. A challenge for future research remains however to explore how best to motivate a relatively asymptomatic group who are nevertheless at risk. Of course it is also important for future research to ascertain the extent to which pre-diabetics who are not particularly overweight or inactive might actually benefit from lifestyle change.
In terms of actual lifestyle behaviours, scores on the eating measure suggested eating patterns at the healthy end of the scale, with room for improvement. A detailed analysis of responses to this scale is beyond the scope of this paper, but it would be of value to explore the eating patterns of different groups in larger comparative samples than are currently available. Such an analysis would assist in the development of targeted interventions for different cultural, social or gender groups. With respect to activity/inactivity, an important aspect of this study has been to measure both dimensions of physical behaviour. The cultural and gender groups did not show main effect differences on activity (although the interaction indicated the importance of more fine-grained analysis). However, cultural group differences in levels of inactivity point to the importance of discussion, in healthy living interventions, of alternatives to ‘sitting around’ as leisure, and antidotes to sedentary lifestyles.

There were also cultural differences in mood variables, with Chinese participants displaying lower levels of positive affect than Anglo-Australians. In addition, while females displayed higher overall levels of depression than males, this was particularly pronounced in the case of Chinese women. Furthermore there was a negative association between depression, self efficacy measures and motivation to change, both of which have been shown to be important to successful diabetes self care (DeCoster & George, 2005; Sarkar et al., 2006; Williams & Bond, 2002). While this cross sectional study does not enable assumption of cause and effect, these findings nevertheless support previous research that documents the potential for depression to have a detrimental effect on diabetes self care and maintenance of healthy eating and exercise patterns (Egede et al., 2005; Katon et al., 2005; Lin et al., 2004). Depression in its own right may pose a significant barrier to successful lifestyle changes and needs to be addressed in any generalist or diabetes specific lifestyle interventions.

Whilst these findings raise a number of important issues to be considered in the planning and delivery of lifestyle interventions for the prevention of Type 2 diabetes, a number of limitations need to be considered. First, some of the measures designed for this study (e.g. self efficacy, diabetes knowledge, eating behaviours and physical activity) have yet to be validated. While these measures all showed adequate alpha reliabilities, and did successfully differentiate between groups and relate to each other in meaningful ways, future research could involve an increased level of validation of these scales.

A further issue for consideration is that the Chinese group was relatively small and highly educated. While education was not found to be a significant covariate, it is not clear the degree to which the current findings will generalise to the wider ethnic group. Finally it is important to note that there was a large variation in the effect sizes for the analyses of cultural differences, with most of the effect sizes being small. The effect sizes of culture on biochemical indicators, diabetes related knowledge and behaviour were small. The effect sizes for mood, self efficacy, and motivation to change were moderate, while the effect size for anthropometric differences were large. These findings indicate that further exploration with a larger and more diverse Chinese sample would be useful.

In conclusion, the current study has demonstrated that there are group differences (in this case associated with a cultural group) and some gender differences in the manifestation of pre-diabetes in the current Chinese and Anglo-Australian sample. The main implication of these findings is the need to apply a specific rather than a generalist approach to diabetes prevention programs, and to tailor lifestyle interventions to suit the individual needs of the group being targeted. While not the focus of the current investigation, differences in profiles between regional and metropolitan pre-diabetics also need to be explored in the quest to tailor healthy lifestyle interventions to fit their cultural and social contexts.

References


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